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(54) **IMPACT SCREWDRIVER**

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(51) **Int. Cl.**

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B25B 15/02	(2006.01)
B25B 15/00	(2006.01)
B25B 17/00	(2006.01)

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CPC ***B25B 21/02*** (2013.01); ***B25B 15/02*** (2013.01); *B25B 15/00* (2013.01); *B25B 17/00* (2013.01)

(58) **Field of Classification Search**

CPC B25B 21/00; B25B 21/02; B25B 15/00; B25B 15/02; B25B 15/04; B25B 17/00
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See application file for complete search history.

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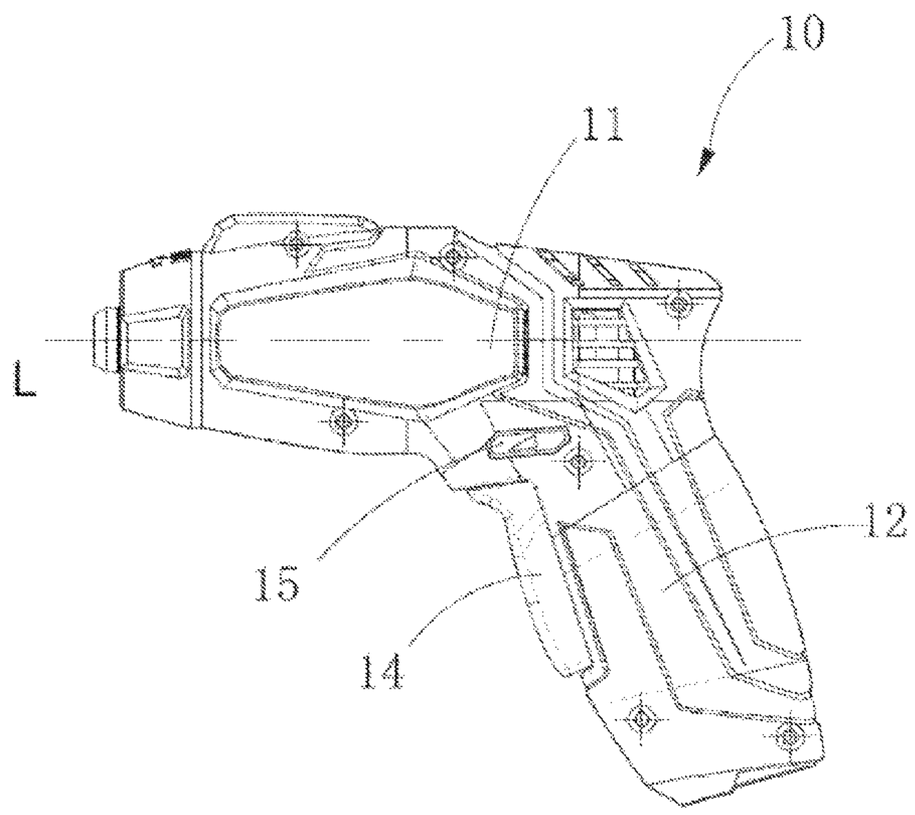
(57) **ABSTRACT**

An impact screwdriver includes a housing, a battery arranged in the housing, an electric motor arranged inside the housing, a transmission part driven by the electric motor and an impacting part, the impacting part including a hammer, an anvil matched to and hammered by the hammer, and an output shaft revolved by the anvil, wherein the rated voltage of the battery is less than or equal to 4.25V, the impact frequency of the hammer and the anvil is at least 30 Hz, and the ratio of the output torque (Nm) of the output shaft to the rated voltage of the battery is 1.8~4.5.

9 Claims, 3 Drawing Sheets



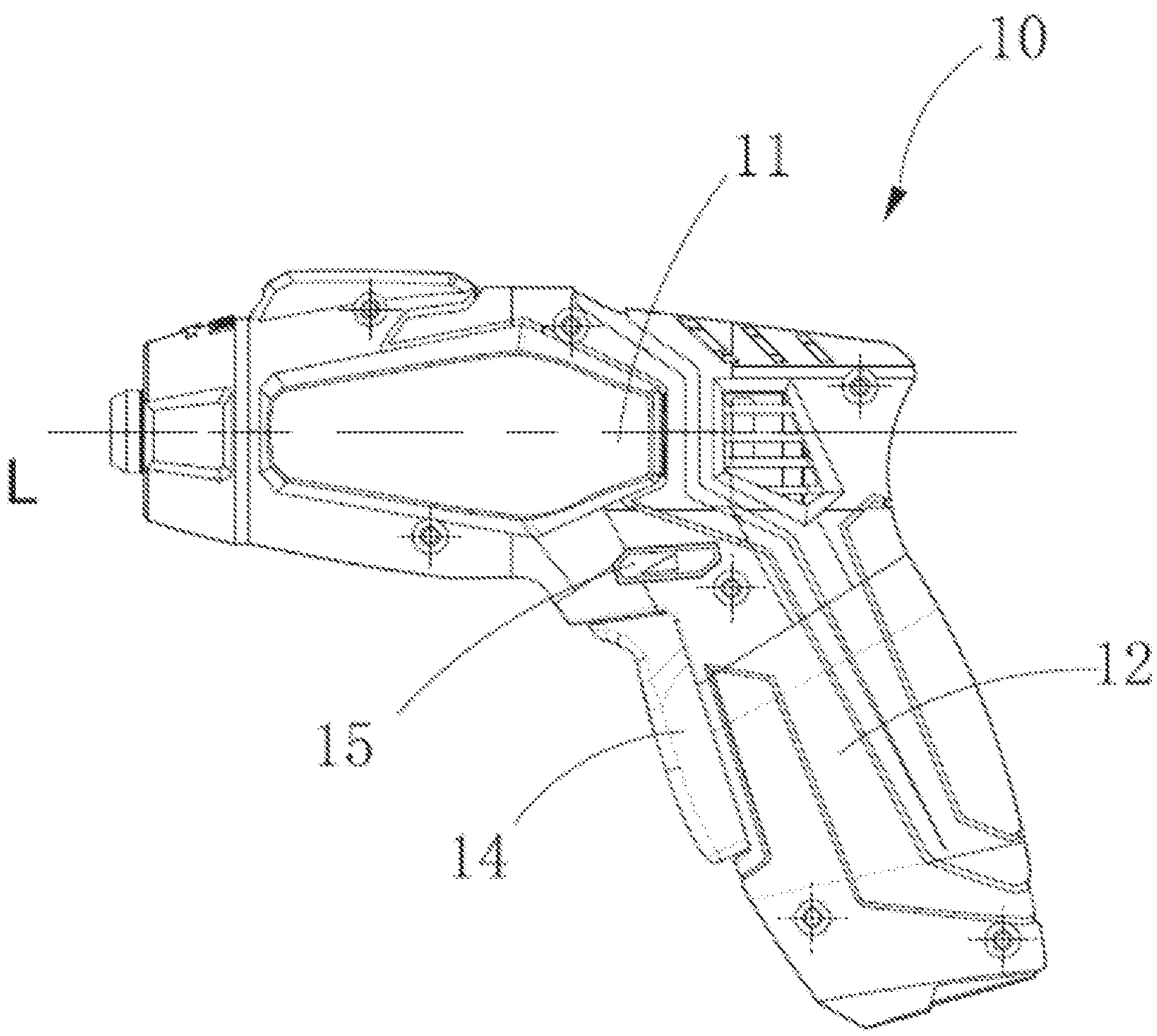


FIG.1

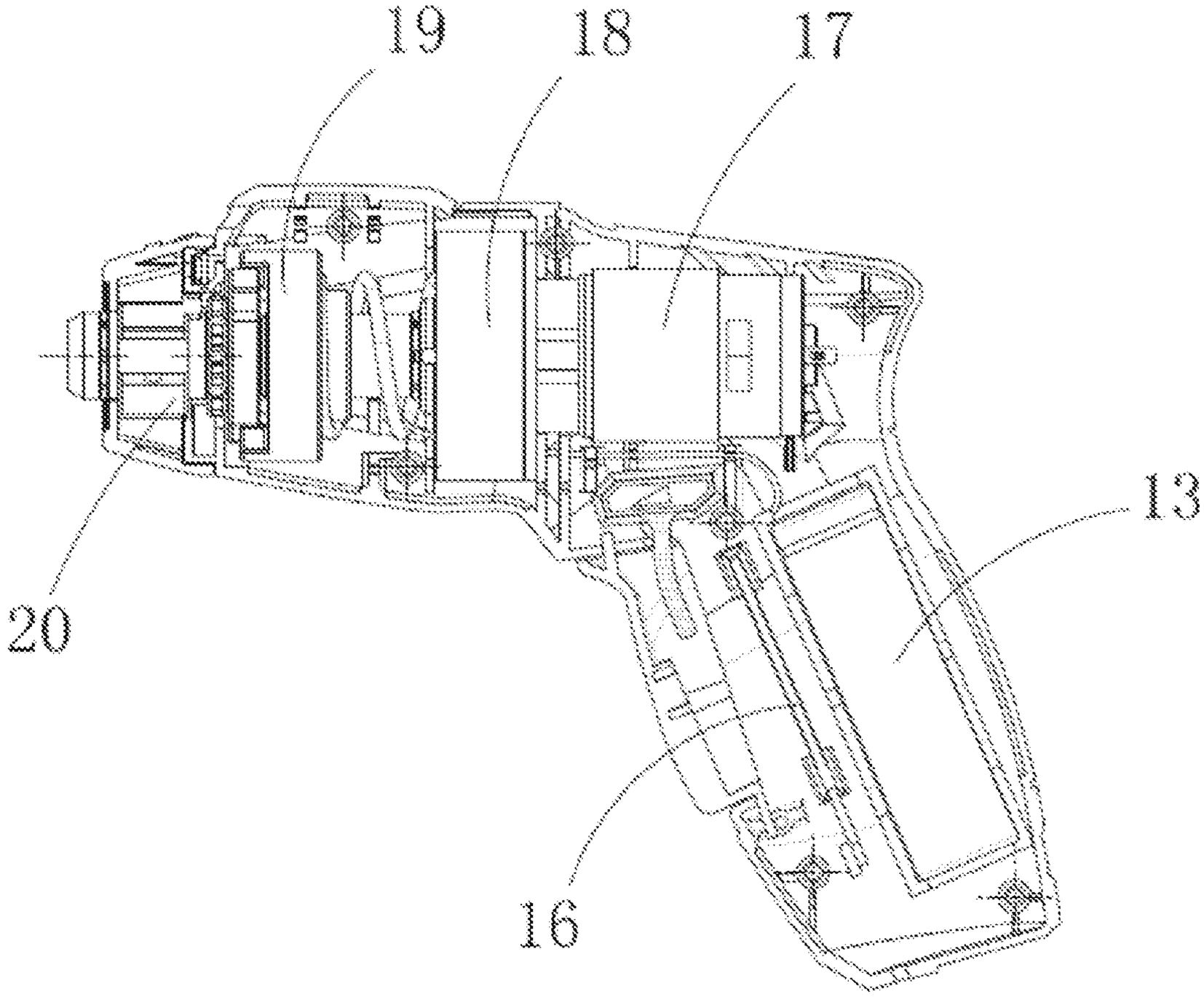


FIG.2

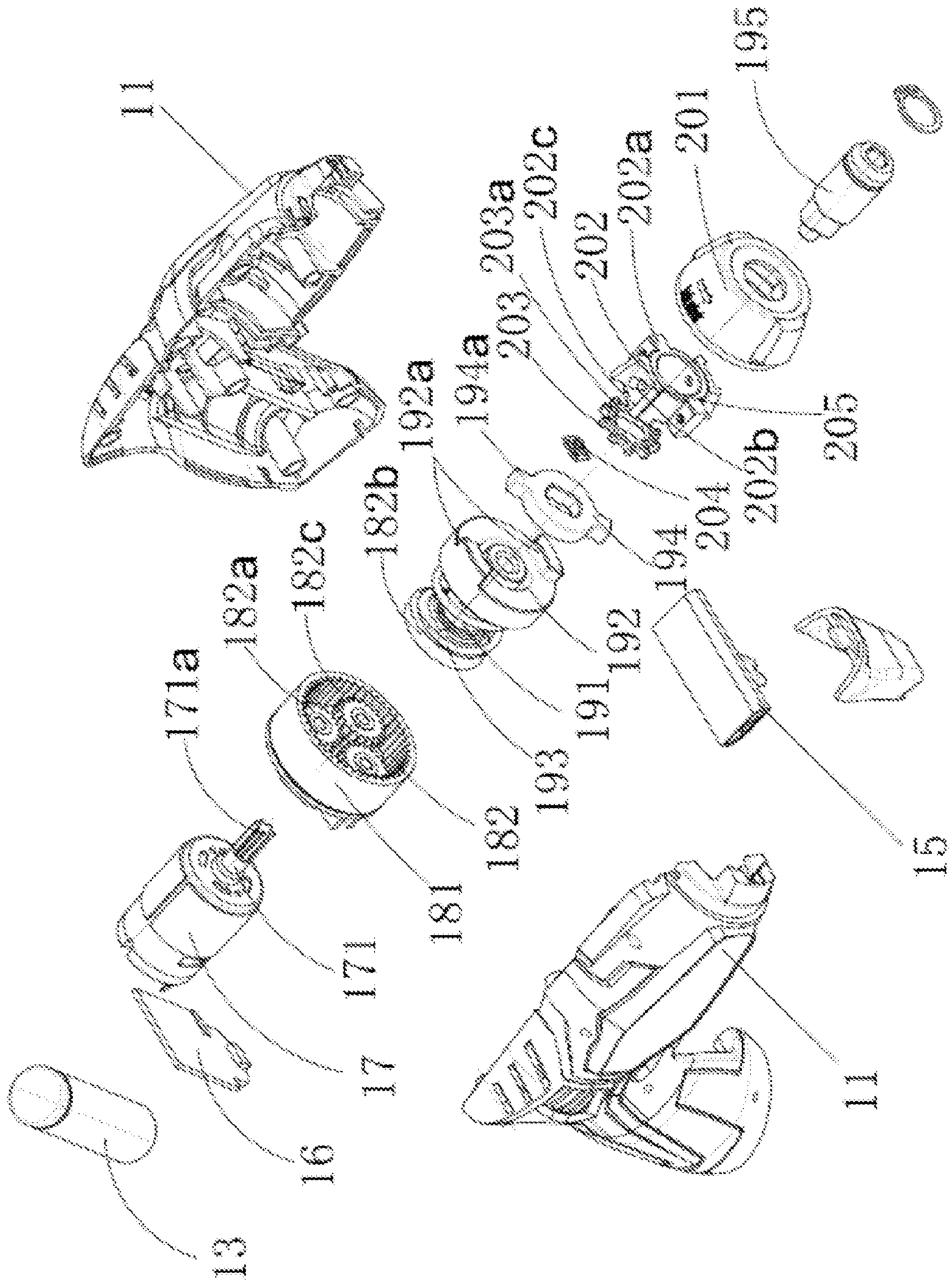

11
171a
182a
182c
182b
192a
194a
203
203a
202c
202
202a
201
195
171
181
182
193
191
192
194
204
202b
205
15
16
17
13

FIG.3

IMPACT SCREWDRIVER

RELATED APPLICTION INFORMATION

This application claims the benefit of CN 201310713648.9, filed on Dec. 20, 2013, the disclosure of which is incorporated herein by reference in its entirety.

TECHNICAL FIELD

The present disclosure generally relates to a hand-held electric tool and, more particularly, to an impact screwdriver.

BACKGROUND

A screwdriver is a common household tool having the advantages of being quick and portable, cheap and practical, and widely usable. A common screwdriver usually cannot screw completely or may cause slip with overexertion in the process because of the constraints of output torque, which brings unnecessary duplications of effort or in the steps of switching manual tools to avoid slip and thus results in tedious work and poor user experience.

In this case, an impact screwdriver with an additional impact function is generally required, while tightening screws, an output shaft of the impact screwdriver applies an impact force on the screw with a predetermined frequency by the driving of a motor, to improve work efficiency. However, for DIY users, impact screwdrivers on the market are too expensive to be popular. In addition, because tools are used in different working conditions, common impact screwdrivers cannot be fully competent in narrow space because of the larger size, while small screwdrivers cannot meet demand because of the low voltage output torque.

The statements in this section merely provide background information related to the present disclosure and may not constitute prior art.

SUMMARY

The object of the present disclosure is to provide a compact impact screwdriver with low voltage and high output torque.

More particularly, the present disclosure describes an impact screwdriver, including a housing, a battery arranged in the housing, an electric motor arranged inside the housing, a transmission part driven by the electric motor and an impacting part, wherein the electric motor has a driving shaft to provide a rotational output, and the transmission part decelerates the rotational output of the driving shaft and then provides a rotational output, the impacting part comprising a hammer, an anvil matched and hammered by the hammer, and an output shaft revolved by the anvil, wherein the rated voltage of the battery is less than or equal to 4.25V, the impact frequency of the hammer and the anvil is greater than 30 Hz, and the ratio of the output torque (Nm) of the output shaft to the rated voltage of the battery is 1.8~4.5.

Further, the output torque of the output shaft may be at least 8 Nm.

Further, the rated voltage of the battery may be 3.6V.

Further, the hammer, the anvil and the output shaft of the impacting part may be powder metallurgical parts or precision castings, and the anvil and the output shaft may be capable of being integrated or independent parts separately formed.

Further, the impact screwdriver may also include a shaft locking mechanism capable of switching the impact screwdriver between an electric operation and a manual operation.

Further, the shaft locking mechanism may include an operating element mounted on the housing that is operatable between a locked position and an unlocked position, a first engaging element connected to the operating element, and a second engaging element arranged on the output shaft, wherein the first engaging element has a first position distal from the second engaging element and a second position at which the first engaging element is driven by the operating element to move and engage the second engaging element.

Further, the outer surface of the first engaging element may have a plurality of protrusions, a sliding slot may be provided on the housing for the axial movement of the first engaging element, and a plurality of grooves may be formed on the outer circumferential surface of the second engaging element to match with the protrusions.

Further, the operating element may be arranged to revolve around the housing, the outer surface of the first engaging element may have a chute in which a pin is arranged within which the pin is capable of sliding by the revolving of the operating element to force the axial movement of the first engaging element.

Further, the shaft locking mechanism may also include a shaft locking switch triggered by the operating element to control the on-off operation of the motor circuit.

Further, the battery may be a lithium battery.

An impact screwdriver constructed according to the present disclosure with fulfill the demands of low voltage and high output torque as well as being portable and compact for use in a narrow space.

Further areas of applicability will become apparent from the description provided herein. It should be understood that the description and specific examples are intended for purposes of illustration only and are not intended to limit the scope of the present disclosure.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a front view of an exemplary impact screwdriver constructed according to the present disclosure;

FIG. **2** is a cross-sectional view of the impact screwdriver of FIG. **1**; and

FIG. **3** is an exploded schematic view of the impact screwdriver of FIG. **1**.

The drawings described herein are for illustrative purposes only of selected embodiments and not all possible implementations, and are not intended to limit the scope of the present disclosure. Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

DETAILED DESCRIPTION

The following describes in detail an exemplary impact screwdriver with reference to the attached figures. The following description is intended to be merely exemplary in nature and is in no way intended to limit the claimed invention, its application, or uses.

By reference to FIGS. **1-3**, an exemplary impact screwdriver **10** is illustrated in the form of a tool having a shape that is similar to a pistol, and includes a housing **11** which has a substantially cylindrical part, a handle **12** arranged at an angle to the cylindrical part, and a battery **13** arranged inside the handle. The housing **3** has a longitudinal axis L along the length direction of the cylindrical part, a switch **14** is arranged on the handle **12** to control the machine to start, a reversing button **15** is arranged on the adjoining part of the handle **12** and the cylindrical part, which is arranged on the both sides of

the housing to control the machine to reverse, a PCB control panel **16** in front of the battery **13** is arranged inside the handle, a power display interface may be integrated on the PCB control panel **16**, which has a visual display of the charge and discharge process of the tool, additionally, a charge and discharge protection device is arranged in the machine, which protects the charge and discharge process of the whole machine, to ensure the safe operation and working life thereof.

By reference to FIG. **2** and FIG. **3**, one end of the housing **11** which is distal from the handle **12** is taken as the front, the other end as the rear, and an electric motor **17**, a transmission part **18** driven by the motor **17** and an impact part **19** are arranged in turn along the longitudinal axis L from the front to the rear. The electric motor **17** has a driving shaft **171** providing revolving output and a motor gear **171***a* for transferring the power from the revolving output of the electric motor **17** to the transmission part **18** via the gear structure which is arranged on the top of the driving shaft **171**. The transmission part **18** decelerates the revolving output of the driving shaft **171** to provide a revolving output. The transmission part **18** includes a gearbox **181** which accommodates a planetary gear decelerating system **182**. According to the embodiment of the present disclosure, the planetary gear decelerating system is a single-reduction system which includes planetary gears **182***a*, a planetary carrier **182***b* and a ring gear **182***c* fixedly arranged in the gearbox **181**. The planetary carrier **182***b* includes a cylindrical base and a plurality of planet pins evenly spaced on the base surface in the circumferential direction, the planet pins extend from the rear end of the base, a planetary gear **182***a* is arranged on each planet pin, and the driving shaft **171** of the electric motor **17** extends into the gearbox **181** to engage the planetary gears **182***a* accommodated inside.

A hole is arranged on the base of the planetary carrier **182***b*, fixedly connected to the intermediate shaft **191** of the impacting part **19** via an interference fit, thus the intermediate shaft **191** always revolves around the planetary carrier **182***b*. The impacting part **19** includes a hammer **192** arranged on the intermediate shaft **191**, a spring **193** disposed between the hammer **192** and the planetary carrier **182***b*, and a V-shaped groove impact mechanism located on the adjoining part of the hammer **192** and the intermediate shaft **191**, and, since the V-shaped groove impact mechanism noted above is a known mechanism for providing impact, the functionality provided thereby need not be described in further detail herein. A pair of first end gears **192***a* are arranged on the radial symmetric protrusion of the front surface of the hammer **192**, an anvil **194** is arranged in the front end of the hammer **192**, and a pair of second end gears **194***a* are arranged on the radial symmetric protrusion of the rear end surface of the anvil **194** opposite to the hammer **192**. The impacting part **19** further includes an output shaft **195** extending beyond the front of the gearbox **181** and connected to the anvil **194**. It is understandable that the anvil **194** and the output shaft **195** may be integrated or independent parts separately formed. A slot **1951** is arranged in the front of the output shaft **195**, which can receive corresponding working heads while realizing different functions.

Next, the working principle of the impact screwdriver **10** in the embodiment of the present disclosure will be explained in details. The revolving of driving shaft **171** of the electric motor **17** results in a corresponding rotation of the motor gear **171***a* on the driving shaft **171**. This action results in the planetary gear **182***a* rotating around the planet pin, while the planetary gear **182***a* crawls along the annular inner tooth of the ring gear **182***c*, and revolves around the axis of the driving shaft **171**. The planetary carrier **182***b* is rotated by the revolution of the planetary gear **182***a* , and transfers the rotation to the intermediate shaft **191**. The hammer **192** driven by the intermediate shaft **191** reciprocates in the axial direction via the V-shaped groove impact mechanism, and impacts the anvil **194** under the influence of the spring **193**, and finally the impact force is transferred to the output shaft **195** through the anvil **194**.

The impact screwdriver **10** further includes a shaft locking mechanism **20** being capable of switching the impact screwdriver **10** between the electrical operation and the manual operation, the shaft locking mechanism **20** includes an operating element **201** mounted on the housing **11**, a first engaging element **202** coupled to the operating element **201**, and a second engaging element **203** arranged on the output shaft **195**, and a shaft locking switch **204**. The shaft locking mechanism may be operated between a locked position and a unlocked position and, when the operating element **201** is in the unlocked position, the first engaging element **202** is in a first position distal from the second engaging element **203**, the output shaft **195** is unlocked, and the shaft locking switch **204** is not triggered, the electric motor **17** can be opened, the machine can work properly, and when the operating element **201** is in the locked position, the first engaging element **202** is driven by the operating element **201** to move to a second position and engage with the second engaging element, the output shaft **195** is locked, the shaft locking switch **204** is triggered, and the electric motor **17** cannot be powered. By locking of the output shaft **195**, the impact screwdriver **10** is switched from the electrical screwdriver operating mode to the manual screwdriver operating mode, and the circuit of the electric motor **17** is controlled to be disconnected upon being locked, thus the rotation of the electric motor **17** is cut off, and the safety performance of the machine is improved.

Particularly, the operating element **201** is rotatably arranged in the front end of the housing **11** and the body of the operating element **201** forms a cup-shape, which includes an opening for the output shaft **195** to pass through. The output shaft **195** is kept in an axial location through a clamping ring. The first engaging element **202** has a plurality of protrusions **202***a* on the outer surface, accordingly, the housing **11** has a plurality of sliding slots in the front, the first engaging element **202** is axially and movably arranged in the sliding slots along the output shaft **195** via the protrusions **202***a*, a chute **202***b* is arranged on the outer surface of the first engaging element **202**, the operating element **201** is fixedly connected to a pin **205** that is slidably movable in the chute **202***b*, the pin **205** causes the axial movement of the first engaging element **202** by the revolving of the operating element **201**. In other embodiments, the operating element **201** may be fixedly connected to the first engaging element **202** or integrated, an opening chute is arranged on the upper side of the housing **11**, in which the operating element **201** is movable along the axial direction, and the first engaging element **202** moves due to the axial movement of the operating element **201**. A plurality of grooves **203***a* is formed on the outer circumferential surface of the second engaging element **203** to match with the protrusions **202***c* extended from the rear end of first engaging element **202**. When the first engaging element moves axially to the position where the protrusions **202***a* are engaged with the grooves **203***a*, the output shaft is locked. The shaft lock switch **204** close to the operating element **201** along the axial direction is arranged in the front of the housing **11**, a convex surface is arranged on the operating element **201**. When rotating to the lock position, the convex surface triggers the shaft lock switch **204** to cut off the circuit of the electric motor **17**. It can be understood that, in the above implementation of the output shaft **195**, the second engaging element **203** and the

output shaft **195** are two independent elements formed separately, or form an engaging structure on the output shaft **195** directly, by which the first engaging element **201** locks the output shaft **195** directly. Additionally, the shaft lock switch **204** of the shaft locking mechanism **20** is triggered in a mechanical manner, or the lock state of the output shaft is monitored directly by the PCB control panel **16**, and can implement the on-off operation of the circuit in an electrical manner.

The ordinary screwdriver cannot be fully competent in the narrow space because of the larger size, while small screwdriver cannot meet user demands because of the low voltage output torque. In order to overcome the defects above, the battery's voltage and the performance parameters of the impact screwdriver need optimization, the battery used in the impact screwdriver **10** in the embodiment of the present disclosure is a built-in lithium battery. Because the voltage of a battery is usually proportional to the volume, the rated voltage of the battery is set to be less than or equal to 4.25v to reduce the volume, and a preferred range is between 3.6V to 4.2V. The rated voltage of the battery **13** used in the embodiment in the present disclosure is 3.6V, and forms an impact frequency greater than 30 Hz by the 20000 rpm of the electric motor, and a preferred impact frequency is between 35 Hz to 50 Hz; the output torque of the output shaft **195** is at least 8 Nm, and a preferred range is between 8 Nm to 16 Nm; the ratio of the output torque (Nm) of the output shaft **195** to the rated voltage of the battery is 1.8~4.5, and a preferred range is 1.8-4.3, and therefore the output with low voltage and the high output torque are realized.

The impact screwdriver **10** with the above parameters is smaller and more compact than an ordinary screwdriver, and it can be used in both ordinary scenes and narrow space, it is portable and can provide a higher output torque than an ordinary screwdriver, and it is equipped with the shaft locking mechanism **20** to switch between the electrical operation and the manual operation if necessary. Additionally, the elements of the impacting part, such as the hammer **192**, the anvil **194** and the output shaft **195**, utilize molded elements, for example, made of powder metallurgy materials or precision castings, which ensure strength while reducing the product's cost and make it more cost-effective.

The above illustrates and describes basic principles, main features and advantages of the present invention. Those skilled in the art should appreciate that the above embodiments do not limit the present invention in any form. Technical solutions obtained by equivalent substitution or equivalent variations all fall within the scope of the present invention.

What is claimed is:

1. An impact screwdriver comprising: a housing; a battery arranged in the housing; an electric motor arranged inside the housing; a transmission part driven by the electric motor, wherein the electric motor has a driving shaft to provide a first rotational output, and the transmission part decelerates the rotational output of the driving shaft and then provides a second rotational output; and an impacting part coupled to the transmission part comprising a hammer, an anvil matched to and hammered by the hammer, and an output shaft revolved by the anvil, wherein the rated voltage of the battery is 3.6V, the impact frequency of the hammer and the anvil is at least 30 Hz, and the ratio of the output torque (Nm) of the output shaft to the rated voltage of the battery is 1.8-4.5.

2. The impact screwdriver according to claim **1**, wherein the output torque of the output shaft is at least 8 Nm.

3. The impact screwdriver according to claim **1**, wherein the hammer, the anvil and the output shaft of the impacting part are at least one of powder metallurgical parts and precision castings, and the anvil and the output shaft are one of integrated or independent parts separately formed.

4. The impact screwdriver according to claim **1**, wherein the impact screwdriver further comprises a shaft locking mechanism for switching the impact screwdriver between an electric operational mode and a manual operational mode.

5. The impact screwdriver according to claim **4**, wherein the shaft locking mechanism comprises an operating element mounted on the housing that is operable between a locked position and an unlocked position, a first engaging element coupled to the operating element, and a second engaging element arranged on the output shaft; wherein the first engaging element has a first position distal from the second engaging element and a second position at which the first engaging element is driven by the operating element to move and engage the second engaging element.

6. The impact screwdriver according to claim **5**, wherein the outer surface of the first engaging element has a plurality of protrusions, a sliding slot is provided on the housing for providing axial movement of the first engaging element, and a plurality of grooves are formed on the outer circumferential surface of the second engaging element to match with the protrusions.

7. The impact screwdriver according to claim **5**, wherein the operating element revolves around the housing and the outer surface of the first engaging element is provided with a chute in which a pin is arranged for sliding movement by the revolving of the operating element to force the axial movement of the first engaging element.

8. The impact screwdriver according to claim **5**, wherein the shaft locking mechanism further comprises a shaft locking switch triggered by the operating element to control an on-off operation of the motor circuit.

9. The impact screwdriver according to any one of claim **1**, wherein the battery is a lithium battery.

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